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IS AGRICULTURAL INTENSIFICATION PROFITABLE FOR MOZAMBICAN SMALLHOLDERS? AN APPRAISAL OF THE INPUTS SUBSECTOR AND THE 1996/97 DNER/SG2000 PROGRAM

By

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BACKGROUND: Mozambique must increase agricultural production in order to reduce poverty and help feed its rapidly growing population. Increasing yields by using inputs such as chemical fertilizer, improved varieties of seed, and pesticides is an important part of this strategy. The country's prime agricultural lands are also its most densely populated, and tsetse flies in the productive northern areas restrict the use of animal traction for area expansion.

Current crop yields in Mozambique are low compared to other African countries, and improved input use is extremely limited. During 1991-95, Mozambique used 1.84 kg of NPK per hectare of arable land annually, compared to 16.55 kg/ha in Southern Africa, 8.89 kg/ha in sub-Saharan Africa (SSA), 54 kg/ha in Latin America, and 80.3 kg/ha in South Asia. With the end of the emergency programs, which introduced many smallholders to improved seed, most farmers are recycling seed rather than purchasing new stocks.

OBJECTIVES AND METHODS: This report summarizes an appraisal of input use and marketing in Mozambique focusing on the following research questions: (1) what are current smallholder yields for major commodities and what is the potential for increasing yields by using improved technologies? (2) to what extent are improved technologies already being used by smallholders, and are they profitable? (3) how are improved seeds, fertilizer and pesticides produced and distributed? and (4) what are the key constraints to and opportunities for increasing the use of improved technologies by smallholders?

We used a two-part approach to gather data. First, key informants and reports were consulted for information on yields, levels of technology adoption, and production and distribution channels for seed, fertilizer and pesticides. Second, we undertook a survey of 223 smallholders in Manica and Nampula Provinces who participated in the *Direcção Nacional de Extensão Rural*/Sasakawa-Global 2000 program (DNER/SG) in 1996/97. The main objective of the survey was to evaluate the financial and economic profitability of the improved maize technology package used by program participants.

KEY FINDINGS ABOUT THE INPUTS SUBSECTOR: Use of improved inputs by smallholders is limited to cotton and tobacco contract growing schemes and greenbelt vegetable production. Only an estimated 7% of smallholders use purchased inputs, primarily in cotton and tobacco outgrower schemes supported by large agro-industrial companies. Overall use of fertilizer has fallen from 40,000-80,000 tons annually during the early 1980s to approximately 10,000 tons today; pesticide use has fallen from 2-3 million lts/kgs per year to only about 400,000 lts/kgs.

Emergency seed distributions met over half of smallholder seed demand during the 1980s and early 1990s. Most programs have ended, however, and up to 80% of the seed used by smallholders is now saved from year to year.

Substantial yield gains are possible with improved inputs, but fine-tuning recommendations to agroecological conditions is important. Research results indicate that the use of improved seed and fertilizer technologies could increase the yields of major crops by 67%-576%. Current average (potential) yields are: maize 0.4-1.3 tons/ha (5.0-6.5); sorghum 0.3-0.6 tons/ha (0.8-2.0); rice 0.5-1.8 tons/ha (2.5-6.0); bean 0.3-0.6 tons/ha (0.5-2.5); cassava 4-5 tons/ha (5.0-10.0); and cotton 0.3-0.6 tons/ha (1.2).

The response to fertilizer and improved seed varies by agroecological zone and soil type. For the soil types found in the DNER/SG study areas, N and P recommendations for maize ranged from 30-100 kg/ha and 0 to 60 kg/ha, respectively (Geurts 1997). The amounts of N and P applied on DNER/SG plots were 58 and 24 kg/ha in all cases, usually a much lower rate than recommended.

The KRII program has been ineffective in assuring a reliable supply of high quality inputs to smallholder and larger growers. The KRII program has operated since 1986. It supplies an estimated one-third of national pesticide demand and nearly all fertilizer used in Mozambique. These in-kind grants are worth approximately $5-9 million per year. KRII is intended to support smallholder food production, but most of the inputs are routed to large companies for use (often by smallholder contract growers) on cash crops such as cotton and tobacco. Recipients of KRII agrochemicals are supposed to pay a countervalue of 67%-100% of FOB/CIF value into an agricultural development fund, but much of the countervalue goes uncollected.

Companies can access KRII agrochemicals in two ways. First, they can directly request specific products and quantities through the program. This is cheaper than ordering through agrochemical representatives, but it may take up to 18 months between order and delivery. Companies may also have to pay large storage fees if the inputs sit at the docks for a long period. A significant portion of KRII program imports have gone unclaimed and been auctioned after one or two years. This provides a second, even cheaper way to get agrochemicals, if users can find what they need.

Creating a demand for purchased seed among smallholders has been difficult after many years of free seed distribution. Development of the seed subsector since the 1970s has concentrated on the establishment of a formal seed industry similar to those in more developed countries. Formal seed production by SEMOC increased rapidly from 2000 tons in 1988 to nearly 9000 tons in 1994, due almost entirely to emergency program demand by government and NGOs. In the early 1990s, these programs represented over 90% of SEMOC's total business.

With the winding-down of the emergency programs, national seed production fell to just over 5000 tons in 1995. The commercial infrastructure for seed distribution is almost non-existent because the distribution of emergency seeds was carried out through the Provincial Directorates of Agriculture or directly by NGOs.

KEY FINDINGS FROM THE DNER/SG PROGRAM: Yields in 1996/97 were highly variable, due to a combination of natural, administrative, and farmer management factors. Program yields in 1996/97 ranged from 0.5-4.9 tons/ha (Table 1). Mean yield for the sample was 2.3 tons/ha, compared to provincial means of 0.4-1.3 tons/ha and DNER/SG yields in the previous season of 4.6 tons/ha.[1] Many farmers reported late and intensive rains that flooded fields, delaying operations and causing ears to rot in the field. In some areas the late delivery of DNER/SG inputs further delayed planting. Finally, many farmers applied the technology poorly or incompletely in their fields, resulting in much reduced yields. Regression analysis identified plant density, number of days of labor input and weather conditions as important determinants of maize yield.

Financial analysis: due to variable yields, the high cost of inputs, and low maize prices, many DNER/SG farmers lost money from the investment in maize technology. Net income per hectare was calculated for farmers selling maize in June (just after harvest), December, and midway between July and December. Table 1 shows key results from the analysis.

Farmers in the bottom two yield terciles required exceptionally high prices to earn attractive returns. Net

[1]The sample was stratified by agroecological regions (R) and yield terciles.

Table 1. Summary of Results -- Financial and Economic Analyses of 1996-97 DNER/SG Maize Technology Package, by Region and Yield Tercile

	Study Zone														
	Reg.ion 4 (East/Central Manica Province)			Region 7 (Ribaue, Nampula Province)			Region 8 (Monapo/Meconta, Nampula Prov.)			Region 10 (Western Manica Province)			Region 10 (Malema, Nampula Province)		
	Maize Yield Tercile														
Budget Item	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
YIELD (t/ha) 1/	0.9	2.1	3.4	0.5	0.7	1.4	1.2	2.5	3.8	1.2	2.6	3.8	1.3	2.9	4.9
TOTAL FAMILY/MUTUAL LABOR DAYS															
(adult equiv. days/ha)	77	124	102	80	73	105	81	47	73	97	109	132	67	110	88
N used in calculations	14	15	15	5	6	5	8	8	8	12	13	13	7	7	7
FINANCIAL ANALYSIS															
a. Net Income 2/ ('0000 meticais/ha)															
June 97 Price /3	(137.7)	(34.5)	37.5	(90.7)	(77.9)	(44.1)	(44.8)	31.7	124.6	(118.7)	(39.0)	42.2	(40.3)	54.8	169.4
Dec 97 Price /3	(22.6)	272.9	545.5	(77.1)	(52.9)	21.0	(24.1)	86.7	215.8	51.0	341.1	609.3	16.5	204.8	430.7
Jul-Dec 97 Price /3	(90.4)	98.1	259.1	(94.6)	(79.7)	(38.7)	(50.8)	28.4	124.2	(47.3)	125.8	289.9	(36.4)	75.4	210.1
b. Net Income per Family and Mutual Labor Day ('0000 meticais/ha) 4/															
June 97 Price	(1.8)	(0.3)	0.4	(1.1)	(1.1)	(0.4)	(0.6)	0.7	1.7	(1.2)	(0.4)	0.3	(0.6)	0.5	1.9
Dec 97 Price	(0.3)	2.2	5.4	(1.0)	(0.7)	0.2	(0.3)	1.9	3.0	0.5	3.1	4.6	0.3	1.9	4.9
Jul-Dec 97 Price	(1.2)	0.8	2.5	(1.2)	(1.1)	(0.4)	(0.6)	0.6	1.7	(0.5)	1.2	2.2	(0.5)	0.7	2.4
Median wage rate per 8 hour day ('0000 meticais)	2.0	2.0	2.0	1.0	1.0	1.0	1.6	1.6	1.6	1.2	1.2	1.2	0.6	0.6	0.6
ECONOMIC ANALYSIS															
a. Maize Deficit in Southern Africa															
NET INCOME ('0000 meticais/ha)															
HTC 5/	(121.5)	12.0	186.8	(157.8)	(146.7)	(148.1)	(158.8)	(91.5)	(57.7)	(64.6)	92.7	236.1	(106.2)	(67.6)	0.4
LTC 6/	(95.5)	68.6	275.3	(115.2)	(91.4)	(48.3)	(68.6)	77.2	193.6	(29.9)	160.8	333.9	(15.7)	126.8	318.6
Export to Malawi	(not a viable option at this time)			(87.1)	(51.2)	34.2	4.7	225.1	419.8	(not a viable option at this time)			58.0	299.1	608.3
b. Maize Surplus in Southern Africa															
NET INCOME ('0000 meticais/ha)															
HTC	(161.9)	(87.2)	26.1	(180.3)	(178.8)	(214.0)	(217.3)	(209.5)	(238.2)	(121.7)	(28.8)	57.4	(165.1)	(205.1)	(230.8)
LTC	(135.9)	(30.7)	114.6	(137.7)	(123.5)	(114.2)	(127.1)	(40.8)	13.1	(87.0)	39.3	155.2	(74.5)	(10.7)	87.4
Export to Int'l Mkt	(not a viable option at this time)			(128.7)	(110.7)	(87.9)	(103.8)	62.8	85.1	(not a viable option at this time)			(51.0)	44.2	179. 65

Source: Field data from /DNER/SG Survey

1/ Estimated from crop cuts. Assumes storage losses of 1% per month.

2/ Gross revenue - (cash costs + interest + purchased labor).

3/ Prices (mts/kg) were: **June**: 653 Region 4, 666 R7, 694 R8, 658 R10; **Dec**: 2419 R4, 1394 R7, 1123 R8, 2045 R10; **July-Dec**: 1426 R4, 838 R7, 787 R8, 1211 R10.

4/ Net income/adult equivalent family + mutual labor days.

5/ Long distance road haulage cost is estimated at USD 0.05/ton/km (Coulter 1995)

6/ Long distance road haulage cost is estimated at USD 0.03/ton/km (Coulter 1995)

income per hectare per day of family/mutual labor can be compared to local wage rates to assess the attractiveness of the technology. Estimated local wage rates varied from 6000 to 20,000 meticais[2] per day. Except in Region 10, the bottom two yield terciles required the exceptionally high prices of December 97 for daily earnings to exceed these wage rates. Incomplete or poor application of the technology and late arrival of inputs are important reasons for the low yields realized by these farmers. These factors can be addressed through improvements in program management and extension assistance. Natural factors also played a role. However; it is important to realize that these will push yields down for some farmers every year.

During 1996/97, storing maize for several months dramatically increased farmer gains, although this may not be true every year. When farmers sold in June, only 36% made a profit. At the December price, 80% profited; 62% of those selling midway between July and December profited. The proportion of gainers and losers varied considerably by region and period. All of the Ribaue District (R7) farmers selling in June lost money; 25% turned a profit if they waited until December to sell. In East/Central Manica (R4), 27% of farmers made a profit at June prices, while 89% took a profit at December prices.

Economic analysis: farmers in Nampula Province are better off if they export to Malawi, Tanzania, Kenya or elsewhere. We estimated the value of maize production to the Mozambican economy by valuing maize, fertilizer, and seed at world market parity prices. Economic profitability was estimated for the contrasting scenarios of maize deficit and maize surplus in the Southern Africa region (Table 1).

Maize deficit in Southern Africa. When Southern Africa has a maize deficit, Mozambican farmers compete with U.S. or other world maize producers to supply the large Maputo consumer market and other consumers in the region. Three cases were considered: (a) high transport costs; (b) low transport costs; and (c) low transport costs, and Nampula Province farmers export maize to Malawi rather than Maputo.

Even with high transport costs, conditions are favorable for participants in Manica Province (R4, R10), where intensified maize production is profitable for two-thirds of farmers. For farmers in Nampula (R7,R8,R10), far from the Maputo market, intensified maize is barely profitable for the top tercile in Region 10 and unprofitable for all the rest. With lower transport costs, profits increase for Manica Province farmers, but are still negative for the lower tercile of farmers. Reduced transport costs do not help farmers in Ribaue (R7), where intensified maize is still unprofitable for all terciles, but seed and fertilizer use becomes profitable for the top two terciles in the rest of Nampula. Nampula farmers are best off when they can export to Malawi rather than transporting the much greater distance to Maputo.

Maize surplus in Southern Africa. When Southern Africa has a maize surplus, Mozambican producers compete with South Africa to supply Maputo. Alternatively, they could export to Malawi or elsewhere; maize production in Malawi has been declining for some years, and during the past two, the country has provided a market for Mozambican maize despite regional surpluses.

Supplying Maputo during a regional surplus is unattractive for all but the highest tercile farmers in Manica province, due to very low prices. Under these circumstances, farmers in northern Mozambique are better off exporting their maize to Malawi or other regions. Weather patterns in Tanzania and Kenya are different from Southern Africa's and may provide a market for surplus Mozambican maize. If export to regional and international markets is possible, the analysis indicates that maize intensification will be profitable for the top two yield terciles in Monapo/Meconta (R8) and Malema (R10).

Credit repayment: DNER/SG is setting a dangerous precedent by not enforcing repayment of input loans made to farmers during 1996/97. As of December 1997, less than 20% of farmers reported making any payments on loans from the previous season. There is a real danger that some farmers may now regard the DNER/SG program as a grant rather than a loan program. Such a precedent would undermine the development of private sector input supply channels in these areas.

CONCLUSIONS AND POLICY IMPLICATIONS: Sustained adoption of improved production technology in Mozambique will depend on policies and programs that increase the profitability of input use by (1) improving smallholder awareness of the benefits and correct use of inputs;

[2] 11,500 meticais=$1

(2) reducing the cost of inputs and ensuring their timely availability; and (3) reducing the cost of marketing commodity outputs and developing new markets for smallholder commodities.

Improve Smallholder Awareness of the Benefits and Correct Use of Inputs. The generally successful DNER/SG experience in Mozambique (and the DNER/SG experience in other countries) suggests that it may be useful to replicate elements of this model elsewhere in the country with maize and other crops.

Since SG and DNER resources are limited, other NGOs, JVCs or private sector firms (including agrochemical and seed firms) could provide support to expanded DNER efforts in this area. Several modifications would increase the program's effectiveness. First, extension assistance must be improved. This will require improved training of extensionists, but perhaps more importantly, improved coordination between participating farmers and the extension service. Farmer associations could play a key role in this process. Second, the process of identifying candidate crops and areas for intensification should include a feasibility study to determine (a) the potential yield gains by crop and region from use of improved technology, and (b) estimates of the farm-level profitability of the input package.

Third, databases from INIA and NGO trials should be used to fine-tune recommendations to specific agroclimatic conditions. The addition of complementary technologies may boost profitability: storage pesticide would allow farmers to take better advantage of potential seasonal price rises, while herbicide would help address the weeding labor constraint, which becomes especially binding when fertilizer is used.

Invest to Reduce Costs and Ensure Timely Availability of Inputs. Input-output price ratios are high in Mozambique. Using June ouptut prices, farmers must produce between 1,504 and 2,074 kilograms of maize to pay for the inputs used on one hectare. Yet our economic analysis suggests that if the export market is developed, especially to Malawi, Nampula farmers can begin to make money with yields of 1 ton per hectare. Manica farmers could earn profits with yields as low as 700 kg/ha. With yields of 3 tons and more attainable on smallholder fields with this technology, the potential profits to farmers become extremely attractive.

Profitability can also be increased by lowering input costs. Major factors affecting costs are the poor state of transportation infrastructure (transport and handling costs between the port and farmgate add 31-64% to the import parity price of fertilizer), the lack of wholesale and retail outlets for inputs in the rural areas, and weak demand for fertilizer and seed by smallholders. Input dealers cannot deal in quantities large enough to realize significant economies of scale. We recommend the following:

Improve transport infrastructure. The Mozambican government and donors are well aware of the need to improve transport infrastructure: roughly half of Mozambique's estimated 43,000 kms of paved, earth/gravel, and feeder roads are scheduled for rehabilitation by the year 2000. Additional investments will be required to upgrade the remaining portions of the network and maintain improved road surfaces.

Reorient the KRII program. We propose that the centralized ordering and distribution system for KRII inputs be abandoned and that the program become mainly a financing mechanism for private firms and farmer associations. Using KRII funds as a source of credit, but leaving ordering and importing in the hands of the Mozambican private sector would reduce costs through economies of scale and the long time lag between order and receipt of KRII goods. If it is not possible to reconfigure KRII in this way, the program should be eliminated.

Broaden the role of farmer associations in input and output marketing. Building smallholder demand for improved inputs while creating a network of wholesale and retail input suppliers will be a long-term process. Government and donor funds could be used to strengthen the capacity of smallholder associations to aggregate input orders, guarantee payment, and repackage bulk orders for delivery to individual customers. The innovative experiment by the Cooperative League of the USA (CLUSA) should be studied more closely to determine how the model could be expanded in a cost-effective way.

Reduce barriers to market entry. Policy changes have made it easier to import and sell inputs, but several administrative barriers to market entry remain. Retail licenses must be approved by provincial governors and are difficult and time-consuming to obtain, for example. Lack of credit is widely perceived to be a major constraint; however, the severity of the problem is not well understood,

and the discouraging experience with credit programs in many SSA countries suggests the need for caution.

Discontinue direct distribution of inputs by government and NGOs. The Mozambican government and NGOs can encourage the development of input markets by discontinuing the direct distribution of relief or otherwise subsidized fertilizer and seed for commodities that are available commercially, instead providing farmers with vouchers to purchase inputs from local sources.

Provide technical training for stockists. Another important constraint is the lack of retailers in rural areas capable of handling products safely and giving competent advice about their utilization. NGO programs such as Citizens Network are training shopkeepers in Manica Province in collaboration with SG. In Zimbabwe, CARE's AGENT program provides initial credit guarantees to stockists.

Decentralize seed production and marketing. For the foreseeable future, most seed demand in Mozambique will be for open-pollinated varieties. SEMOC, together with INIA, DNER and the public seed organizations, can help develop a multi-tiered seed sector in Mozambique to better serve the needs of smallholders. First, SEMOC and others can reduce their costs by decentralizing seed production and marketing. This will require joint efforts by companies, public agencies and NGOs to (a) provide links to NARS, international research centers and private sector firms to get information and appropriate varieties; (b) train extension agents; (c) train and supervise farmers in seed production, selection, storage and marketing; and (d) provide technical training to rural stockists.

Review seed system regulations and functions. Seed subsector regulations need to be rationalized to encourage the development of the informal seed sector. We recommend a two-tier seed multiplication and distribution system. At the first level, foundation seed would be multiplied to certified seed and made available for sale under the stringent conditions currently required by seed authorities. In the second stage, seed from the first level would be bulked and marketed as standard seed by individual farmers and farmer groups in local villages, under inspection by extension workers.

Removing compulsory seed certification and restrictive trade licensing requirements will permit production of quality open-pollinated maize and other crops by smallholders and sale among neighboring farmers. In addition, seed companies will be able to involve smallholders in contract seed production more easily.

Reduce the Cost of Marketing Outputs and Develop New Output Markets. Increasing the demand for improved inputs by smallholders ultimately depends on expanding the post-harvest market for commodities they produce. It will be especially important to develop foreign markets for Mozambican commodities. In addition to the points mentioned above, the government can facilitate regional trade in two ways.

Making a clear policy statement that maize exports will not be prohibited even during drought years. If traders expect that government will close off profit opportunities during years of regional deficit, they will not invest in their capacity to efficiently and regularly assemble and export large quantities of grain. The result will be continued small-scale operations, high costs, low prices to farmers, and high prices for consumers.

Government-private sector collaboration to create a regional trade information network. An effort is currently underway in MICTUR and should be strengthened. It will be important to coordinate this effort with the existing market information system (SIMA) in the Ministry of Agriculture and Fisheries. If successful, such a network could eventually provide the basis for an agricultural commodity exchange in the area.

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